What kinds of green infrastructure are cities in Ohio implementing and what are the possible barriers to implementation?

Honors Thesis City & Regional Planning

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Abstract:

As climate change brings increasing precipitation to the Midwest and more specifically Ohio, cities will need to ensure that their stormwater management systems are capable of handling this extra water. Green stormwater infrastructure is one way to complement the gray infrastructure systems already in place by reducing the volume of stormwater that goes to the combined sewer systems. This study focused on interviewing relevant stormwater professionals from five different cities within Ohio: Cleveland, Toledo, Columbus, Cincinnati, and Athens, to determine what kinds of green infrastructure they were adding and what some of their barriers or obstacles to implementation were. The results of the interviews were that cities are implementing a variety of kinds of green stormwater infrastructure, including permeable pavers, bio-retention cells, green roofs, rain gardens, rainwater harvesting, tree canopy, and soil cells. The most frequently mentioned challenge or concern was maintenance, especially in terms of who was responsible for completing it and making sure that person understood how to maintain these projects correctly. Other barriers included challenges during construction due to under-informed contractors and difficulties in gaining community support. Although there were some challenges associated with them, funding and policy were not as much of an obstacle as expected. Other factors that were anticipated to be major barriers but ultimately were not include the number of departments in charge of project implementation, the education of elected officials, and an overall consideration of green infrastructure as a priority for these cities. As a final note, it is likely that more green stormwater infrastructure projects will be implemented in Ohio.

Chapter 1: Introduction/Overview

As global warming and climate change continue to alter the norms of current weather patterns, it is relevant to consider if the gray infrastructure systems in place today are capable of

handling changing weather events, especially in terms of precipitation. With gray infrastructure being the traditional drains, pipes, and water treatment facilities that are associated with sewage and stormwater systems. There are already several examples of outdated combined sewer systems, with many in the Northeast and Great Lakes regions of the country, which cannot handle recent precipitation events let alone any increases in the future (Combined Sewer Overflow…). The EPA has been working to improve the issue of Combined Sewer Overflows since the mid 1990's through multiple policies and enforcement initiatives (Combined Sewer Overflows Policy…). This further asks the question: are the efforts and mandates from the EPA that prevent combined sewer overflows incentivizing cities to implement alternative forms of infrastructure, like green infrastructure? According to the EPA, "Green infrastructure uses vegetation, soils, and other elements and practices to restore some of the natural processes required to manage water and create healthier urban environments" (What is Green Infrastructure). There are various kinds of green infrastructure that serve multiple functions and it is important to know how and why cities are implementing these projects, whether it is solely for stormwater management or for the variety of ecosystem services green infrastructure provides. It is also necessary to consider the barriers and challenges that cities are facing during the implementation process. This research focuses specifically on the types of green infrastructure cities in Ohio are implementing in preparation for more intense precipitation events, and what the possible barriers to implementation are in these cities.

Chapter 2: Literature Review

Climate change is expected to have a variety of impacts across the world, but for the Midwest region of the United States, more precipitation and more intense rain events are anticipated. Many cities have outdated combined sewer and stormwater infrastructure systems

that fail to process both sewage and stormwater during heavy rain events, resulting in combined sewer overflows to the nearest body of water. These infrastructure systems are built to accommodate past rainfall standards and struggle to meet current precipitation levels. So this research looks at if cities are using green infrastructure to meet their stormwater management demands.

Due to a variety of factors the temperature of the Earth is rising, which in turn is affecting climate and weather systems. One of the major impacts that will result from global warming is changes to current precipitation patterns (Trenberth, 123). According to Keven Trenberth in the article “Changes in precipitation with climate change:”

> Increased heating leads to greater evaporation and thus surface drying, thereby increasing the intensity and duration of drought. However, the water holding capacity of air increases by about 7% per 1°C warming, which leads to increased water vapor in the atmosphere. Hence, storms, whether individual thunderstorms, extratropical rain or snow storms, or tropical cyclones, supplied with increased moisture, produce more intense precipitation events. (Trenberth, 123).

In other words, the warmer temperatures associated with global warming allow the atmosphere to hold more water vapor, so when there is a rain event, the additional moisture contributes to more intense rainfall events than have been previously experienced. Furthermore, research has been conducted showing that areas which are experiencing increases of total precipitation have also likely experienced increases in extreme precipitation events (Dore, 1177). So, not only are certain areas seeing higher levels of total precipitation, but they are experiencing them in more intense or heavy rainfall events.

More specifically in terms of the Midwest, rising temperatures along with flooding and more intense weather events will disrupt existing ecosystems (Pryor, et al, 419). Even though in the Midwest the growing seasons are expected to lengthen and some crops will have better growth with global warming, the overall agricultural yield is expected to decrease due to the stress caused by intense weather (Pryor, et al, 419). Climate change will cause other instances of concern like forests shifting further north and therefore altering net carbon dioxide absorption for the Midwest, public health concerns related to more frequent and severe heat waves with worse air quality, and increased threats to the Great Lakes, some being invasive species and algae blooms (Pryor, et al, 419). More relevant to this research are the concerns associated with extreme precipitation, flooding, erosion, and worsening water quality (Pryor, et al, 419)

Many current stormwater management infrastructure systems are sized using historical data and records of rainfall amounts. Most hydrological infrastructure is designed with the maximum capacity of a 100-year storm, meaning that the system is built to support the amount of precipitation that falls in a heavy rain event that statistically happens once every 100 years (Wright, et al, 8144). However, it is no longer relevant to solely base the current and future gray infrastructure systems off past rainfall events because future precipitation patterns will be different. Since 1950, these 100-year storms have been occurring more often (Wright, et al, 8144). “Thus, if the properties of extreme rainfall have changed in recent decades, these IDF [intensity-duration-frequency] standards and the hydrologic designs based upon them may be unreliable now or in the future” (Wright, et al, 8144). Therefore, a new algorithm that includes the shifting variables of climate change will need to be developed for the continued reliance on gray infrastructure (Forsee and Ahmad, 865). With this information in mind, it is relevant to consider if current gray infrastructure systems alone are capable of handling more intense

precipitation events and further, if the current systems are not adequate, what is being done to prepare for future heavy rain events?

Green Infrastructure

In terms of current infrastructure across the country, multiple cities in the United States have outdated drainage systems that cannot handle the current amount of stormwater runoff (Chaffin, et al, 431). Some of these cities have a combined sewer and storm system so when the drainage systems get more storm runoff than they can handle, it can lead to combined sewer overflow events, where both sewage and stormwater drain into the nearest body of water (Combined Sewer Overflow…).

One major challenge of traditional gray infrastructure is that it is costly and complicated to repair or replace partially due to the fact that it is buried underground (Chaffin, et al, 432). While green infrastructure also has some potential complications associated with maintenance, it can be less expensive and potentially cost saving in the long term (Chaffin, et al, 432). As stated in, "A Tale of Two Rain Gardens: Barriers and Bridges to Adaptive Management of Urban Stormwater in Cleveland, Ohio,"

> GI [Green Infrastructure] is an attractive alternative for managing stormwater because it can increase the capacity for stormwater volume capture and detention within urban watersheds… By utilizing natural processes including interception and infiltration, GI can slow the timing of runoff conveyance to receiving waters and can also reduce the actual amount of runoff volume reaching engineered 'gray infrastructure' (i.e., wastewater conveyances) (Chaffin, et al, 432).

Therefore, one potential way of strengthening current systems to prepare for more intense rain events is through the implementation of green infrastructure.

Green infrastructure has a variety of definitions; one description is, “an interconnected network of multifunctional green-spaces that are strategically planned and managed to provide a range of ecological, social, and economic benefits” (Matthews, et al, 156). Another explanation from the American Society of Landscape Architects is, “When nature is harnessed by people and used as an infrastructural system it's called ‘green infrastructure’"(Silverstein and Green). According to the United States Environmental Protection Agency, green infrastructure is a more resilient and sustainable approach to managing stormwater largely because it provides cost saving opportunities, in addition to flood protection and environmental benefits (What is Green Infrastructure). Green infrastructure has a variety of associated benefits and can provide ecosystem services including water filtration, air filtration, micro-climate regulation, noise reduction, wildlife habitat, and cultural value (Bolund and Hunhammar, 295-298). Some literature will specify ‘green stormwater infrastructure’ to eliminate potential confusion and to articulate the specific feature of green infrastructure to which they are referring.

With the increasing intensity of rainfall events, traditional gray infrastructure systems are becoming overwhelmed. Green infrastructure can help slow the rate of stormwater runoff and therefore keep the gray infrastructure functioning as intended, while also providing a variety of ecosystem services consistent with other forms of nature (Keeley, et al, 1094). There are numerous kinds of green infrastructure and the ones listed by the United States Environmental Protection Agency include downspout disconnection, rainwater harvesting, rain gardens, planter boxes, bioswales, permeable pavements, green streets and alleys, green parking, green roofs, urban tree canopies, and land conservation (What is Green Infrastructure). Additional examples can include urban forests, public parks, community gardens, and urban wetlands (Matthews, et al, 156).

In reference to water filtration specifically, stormwater often carries a variety of pollutants from urban runoff and one particular benefit of green infrastructure is that water can be filtered directly on-site through the use of soils and vegetation. Certain green infrastructure designs can remove approximately 90% of total suspended solids, organic pollutants, and bacteria (Chaffin, et al, 432). Furthermore, the clean water can potentially be returned back to the available groundwater source rather than a treatment facility (Chaffin, et al, 432). In contrast, typical gray infrastructure diverts water to a purification plant through a series of drains and pipes. In terms of resiliency, this constructed network of pipes and water sanitation facilities could be a liability both in terms of aging infrastructure, like rusting pipes, or during severe weather events, like hurricanes, tornadoes, etc. and if damaged, presents additional complications in access to clean water (Venema and Temmer, 2). Ultimately, green infrastructure can provide a significant benefit of being able to purify stormwater and improve water quality.

Implementation Strategies and Barriers

A prominent difficulty in the implementation of green infrastructure is that its definition can be ambiguous among professionals (Matthews, et al, 156) and its intended functions are sometimes unclear. Green infrastructure can be a vague term, so one of the questions in this research specifically asks stormwater professionals what their criteria for green infrastructure are and to list certain features that they look for in these projects. The term ‘green-space’ has been used interchangeably with green infrastructure and while green-spaces can be a form of green infrastructure, there are specific functions that green infrastructure provides that green-spaces do not (Matthews, et al, 157). In other words, by incorporating green infrastructure, a community can also incorporate green-spaces, along with the associated ecosystem services and benefits (Matthews, et al, 157), but adding green-spaces may not bring the same functions as a green

infrastructure project. Listing the specific function when referring to these projects can help make their purpose clearer, so for example saying green stormwater infrastructure instead of just green infrastructure. In regards to this study, green infrastructure predominantly refers to green stormwater infrastructure, unless otherwise noted.

One way to make the benefits of green infrastructure more tangible would be to assign dollar values or a common currency towards the ecosystem services associated with a project, like air or water filtration (Matthews, et al, 158). Furthermore, this establishes green infrastructure as a type of natural capital, which can be useful in terms of economic development (Matthews, et al, 158). Another way to potentially distinguish green infrastructure, is that the physical, social, and economic benefits it provides could be stressed as a necessity for stormwater management rather than an amenity (Matthews, et al, 157).

A lack of awareness or understanding about green infrastructure can also create problems for implementation. If a local government does not know what green infrastructure is or why it is useful, they will not implement it. Similarly, if the general public does not understand what green infrastructure is or what is does they may not be receptive to it. However, if at least the general public or the elected officials are aware of green infrastructure, they can help to educate the others. "Inevitably, people are part of the problem and public education and outreach will be part of the solution. Effective education and outreach are essential for promoting conservation policy, creating knowledgeable citizens, changing people's behaviors, garnering funds, and recruiting volunteers" (Jacobson, et al, 1). Informing both the general public as well as elected officials and administrators, can help communities comprehend how and why green infrastructure may be utilized and if desired, can further shape policies to be more inclusive.

Chapter 3: Research Design

This study involved semi-structured interviews with stormwater professionals from five different cities within the state of Ohio. The purpose was to gain a greater understanding of green infrastructure implementation across the state. The state of Ohio has five different regions: Northeast, Northwest, Central, Southeast, and Southwest, as recognized by the State and the EPA (see Figure 1). The five cities that were selected to represent each region of Ohio include Cleveland (Northeast), Toledo (Northwest), Columbus (Central), Cincinnati (Southwest), and Athens (Southeast). Some cities have a larger regional entity that also implements green infrastructure, including Toledo and Cleveland, so the Toledo Metropolitan Area Council of Governments (TMACOG) and the Northeast Ohio Regional Sewer District (NEORSD) were also part of the study, so stormwater professionals from these entities were interviewed. Finally, a representative from the Ohio EPA provided a brief conversation about potential barriers and helped determine if any particular city or project should be included within the study.

Figure 1 - https://ohio.org/regions/

The locations were selected using a purposive sampling method based on the city with the largest population size in each region. Larger cities would be expected to have more

resources and more of a need to implement green infrastructure due to higher population densities and more impervious surfaces. However, even though the largest city in Southeast Ohio is Zanesville, the second largest city of Athens was selected for the study. Athens and Zanesville are very close in population size, yet the difference was that Athens has Ohio University. Every other city in the study has a major educational institution within its boundaries and since the largest cities in Southeast Ohio are significantly smaller than other parts of that state, the major institution in Athens made it more comparable to the other cities in the study (see Table 1).

Table 1: Selection of Cities

City	**Region**	**Population Size** (2017 US Census Bureau)	**Major Institution**
Cleveland	Northeast	385,428	Cleveland State University
Toledo	Northwest	276,618	University of Toledo
Columbus	Central	881,763	Ohio State University
Cincinnati	Southwest	301,648	University of Cincinnati
Athens	Southeast	25,236	Ohio University
Zanesville	Southeast	25,389	N/A

Ohio is an appealing state to study due to its proximity to the Great Lakes, its location as a Midwestern state, and the fact that it has both urban and rural areas being impacted by climate change with increased precipitation, more intense rain events, and an overall decrease in agricultural yield. The advantage of focusing on one state is that all study locations will be operating under the same state level regulations and their climate shifts will be more similar than different. In other words, the differences in green infrastructure implementation between cities will depend primarily on city-level decisions and will not be impacted by varying state structures.

In some ways this project is exploratory because it is mapping out the topic of green infrastructure in Ohio and that could warrant future study. However, ultimately this project is considered as descriptive because it is describing the state of green infrastructure within Ohio. Additionally, this study is cross-sectional because it is determining information about green infrastructure within each city at one point in time: during each interview. Both the unit of analysis and the study population were the locations that were selected to be researched. The sampling process was purposive because the areas were selected based on population size, location, and anticipated interest in green infrastructure.

The goal for the project was to include one city from each region of Ohio and to interview at least one relevant person from each city. The people to interview were identified by looking through google searches and city websites to find experts on stormwater or green infrastructure in each area. First a general Google search of ‘green infrastructure [city name]’ was performed. Usually, the search would reveal a certain city department, a document that the city had created, or an article about a green infrastructure project in the city. In that case, each green infrastructure document, article, or department website was searched to determine if there

was a potential participant to contact. If no potential contact was identified in the search, the city website would be examined next. Each city has different departments, so the stormwater, environmental, or sustainability related entities would be reviewed to find a relevant contact. For Athens specifically, there was some difficulty in getting a response from anyone at the soil and water conservation district or at the city level. So a contact was ultimately identified through an article about a green roof project that was happening at Ohio University.

In some cases, people that were contacted felt that another person would be more knowledgeable and referred their information. In a few situations, the original person contacted would bring another relevant person to their interview, so there were two people talking about their department in one interview. Each city has different departments responsible for stormwater management, so many interviews were from people in sustainability or environmental offices, one was from a parks department, another was from a department of public utilities, and several were from sewer districts. Some cities have regional entities that are responsible for stormwater management, so people with stormwater knowledge at the regional levels were also interviewed.

The conversations with each participant began through a general email about the study and the expectations of the research project and interview. The goal of this preliminary email was to ensure that all participation conformed to the Institutional Review Board human subject standards. If the contact was interested in participating, a phone interview was scheduled. If there was no response after a week, a follow-up email was sent. If there was still no response after several days, an additional person from the city was contacted. Once the participant agreed, the list of questions was sent and an interview time was scheduled. Some contacts did not list an email address or in some cases the email could not be sent due to an error, so in these situations, the contact was called. While snowball sampling was not a primary sampling method, several

participants recommended additional people to either include in the study or to contact in place of them. These additional contacts helped enrich the context of the green infrastructure status of a city.

The interviews were semi-structured with open-ended questions and depending on the interviewee, lasted approximately 15-50 minutes in length. When approved by the interviewee, the conversation was recorded to allow greater accuracy in the analysis process. The questions that were asked in the interviews addressed topics including criteria of green infrastructure, the most successful and most challenging projects, the functionality and complications of construction, challenging parts of implementation, funding sources and budgets, who is in charge of planning, implementation, and maintenance, if green infrastructure is a priority, levels of public support, how the public has been engaged with green infrastructure, and if more projects are going to be implemented (see Appendix A).

Ultimately there were nine interviews that took place (see Table 2). Some interviewees preferred to remain anonymous and others did not. Three interviews were conducted in the city of Cincinnati, one each with the Office of Environment and Sustainability, the Cincinnati Parks Department, and the Metropolitan Sewer District of Greater Cincinnati (MSDGC). Two interviews were conducted for Toledo and those were with the Toledo Metropolitan Area Council of Governments (TMACOG) and the Division of Environmental Services. One interview took place with the Department of Public Utilities in Columbus. Two interviews related to Cleveland and those were with the Mayor's Office of Sustainability and the Northeast Ohio Regional Sewer District (NEORSD). Lastly, one interview pertained to Athens and that was with the Ohio University Office of Sustainability.

Table 2: Interview Contacts

City	Department	Interviewees
Cincinnati	Office of Environment and Sustainability	Anonymous
Cincinnati	Cincinnati Parks Department	Anonymous
Cincinnati	Metropolitan Sewer District of Greater Cincinnati (MSDGC)	Leslie Schehl – Supervising Engineer Ian Laseke – Supervising Engineer
Toledo	Toledo Metropolitan Area Council of Governments (TMACOG)	Kari Gerwin – Director of Water Quality
Toledo	Division of Environmental Services	Anonymous
Columbus	Department of Public Utilities	Leslie Westerfelt – Spokesperson for Blueprint Columbus and Stormwater Education
Cleveland	Mayor's Office of Sustainability	Anonymous
Cleveland	Northeast Ohio Regional Sewer District (NEORSD)	Chris Hartman – Stormwater Technical Specialist Kim Colich – Manager of Stormwater Design
Athens	Ohio University Office of Sustainability	Anonymous

Chapter 4: Findings and Analysis

After all the interviews took place, they were transcribed. The transcriptions were then placed into a spreadsheet and manually coded based on key themes, reoccurring ideas, conflicting ideas, useful conclusions, and potential quotes. The findings from each location were then compared and nine overall categories or themes were formed including Criteria for Green Infrastructure, Common Successes and Challenges of Projects, Functionality, Most Challenging Parts of Implementation, Ownership of Green Infrastructure Projects, Level of Importance, Community Support, Education of Elected Officials, and Additional Factors.

1. Criteria for Green Infrastructure:

As mentioned earlier, there is not one singular definition of green infrastructure, which can lead to some confusion or complication in understanding what it is, why it is important, and how it functions. When each contact was asked what criteria their department uses to distinguish a project as green infrastructure, the responses were varied, but many contained the concept that green infrastructure contributes some sort of additional function that traditional gray infrastructure does not (see Appendix B, 1.1). These functions included carbon sequestration, tree canopy coverage, water quality benefits, providing green space or habitats, reducing greenhouse gas emissions, rainwater harvesting, and re-using stormwater.

The criteria of infiltration was introduced in five of the nine interviews. The requirement of mimicking a natural process or system was discussed twice, and the function of evapotranspiration was also brought up twice (see Table 3). Based on the number of times infiltration was mentioned and its associated benefits of purifying stormwater, improved water quality was determined to be one of the more important benefits of green infrastructure (see Appendix B, 1.2). Another significant benefit of green infrastructure is that it decreases the volume of stormwater runoff that goes into combined sewers (see Appendix B, 1.3), which is especially relevant due to the fact that a majority of the participants in this study are under consent decree from the EPA to reduce their combined sewer overflows.

Table 3: Frequency of Green Infrastructure Criteria

Reoccurring Criteria for Green Infrastructure	**Number of Times Mentioned in Responses**
Infiltration	5
Mimics natural process or system	2

Evapotranspiration	2

In terms of the different types of green infrastructure, several kinds of projects were listed in the interviews (see Table 4). Permeable pavement was brought up the most at three times, bio-retention cells/bio-swales, green roofs, rain gardens, rainwater harvesting, and tree canopy were all listed twice, and soil cells once.

Table 4: Frequency of the Types of Green Infrastructure Projects

Types of Green Infrastructure	**Number of Times Mentioned in Responses**
Permeable Pavement	3
Bio-Retention	2
Green Roofs	2
Rain Gardens	2
Rainwater Harvesting	2
Tree Canopy	2
Soil Cells	1

The main takeaway from the interviews is that green infrastructure is valued for providing additional functions or benefits that traditional gray infrastructure does not, with an emphasis on infiltration and reducing the amount of stormwater runoff going into the combined sewers. There were a variety of types of projects discussed, but permeable pavers were listed the most when questioned specifically about the types of green infrastructure implemented.

2. Common Successes and Challenges of Projects

When asked about their most successful and most challenging projects, one reoccurring challenge that was discussed in six of the nine interviews was maintenance (see Table 5). The

concerns focused primarily on who is and should be responsible for green infrastructure maintenance and upkeep (refer to section 5 for more detail). There were also concerns with adding green infrastructure in residential areas but not getting enough residential support or input. Additionally, there were several instances of finding unexpected objects in the ground during construction, whether that was buried utility lines, basement foundations, or contaminated soils. The successful projects were focused on community engagement, raising public awareness, and overall good communication.

Table 5: Frequency of Project Challenges

Reoccurring Challenges	**Number of Times Mentioned in Responses**
Maintenance	6
Unexpected materials in ground	4
Residential Support	3
Having to coordinate with many people	2

Maintenance is a complicated challenge that was introduced in many of the interviews. A common complaint is a lack of awareness or education in how to properly install and maintain green infrastructure projects, in addition to questions of who is actually responsible for maintenance, which is further discussed in section 5: Ownership of Green Infrastructure Projects.

As Chris Hartman at the NEORSD explained (see Appendix B, 2.1), some types of green infrastructure are easier than others to maintain and are therefore more successful, specifically bio-retention projects. There is less of a learning curve to maintaining bio-retention projects because at the surface, they are fairly similar to most other landscaping projects that the general public is used to. However, projects like permeable pavement systems are unlike ‘normal’ types of landscaping and therefore, have a greater learning curve to maintaining them. This lack of

understanding can lead to neglect and the overall decline of a project. Another example from Chris Hartman at NEORSD (see Appendix B, 2.2) is a specific construction challenge where the contractor did not have an understanding of how the green infrastructure project should function and as a result, installed it incorrectly. The contractor built the catch basin of a bio-retention cell at grade instead of the appropriate 6-12 inches above grade, which drastically diminished the cell's storage capacity and the overall functionality of the project. This concern of if the person doing the maintenance or installing the system is informed and if they are properly caring for the infrastructure, was shared by most other interviewees.

In terms of how to make the maintenance determinations more effective, Leslie Schehl at MSDGC suggested that when maintenance is discussed and planned in the original design, the projects are more successful (see Appendix B, 2.3). However, when maintenance seems to be an afterthought and is not carefully considered, it is more challenging to complete and if neglected, can limit the overall success of the green infrastructure project.

There were additional challenges described when working in residential communities and trying to get resident involvement. The interview with Kari Gerwin at TMACOG included a discussion about how important it is to have the engagement of residents when working in a residential neighborhood and how one project was more challenging because they did not have the support of the adjacent property owner. Additionally, the interview with Leslie Westerfelt at the City of Columbus expressed that projects in residential areas are not always the best-received, especially when there is a lack of input from the community prior to implementation (see Appendix B, 2.4). A lack of advanced or ongoing residential community feedback or engagement can make both designing and implementing green infrastructure projects more challenging, especially in terms of knowing what the community is or is not receptive to.

In terms of challenges directly related to construction, one of the major obstacles was finding unexpected objects in the ground. Whether that was utility lines like in Toledo and Columbus or abandoned basement foundations, as mentioned in an interview with TMACOG. Also, there were some challenges with brownfield sites and soil contamination that limited the types of projects that could be implemented or added costs to the project, as discussed with interviewees from the Mayor's Office of Sustainability in Cleveland and the NEORSD.

The more successful projects were the ones that had good communication, whether that was between designers and maintainers or with the general public (see Appendix B, 2.5). Referring back to Leslie Westerfelt's statement about a lack of residential input, if there is more feedback from the community throughout the whole process, it is more likely that they will approve the final installation. In the Athens interview, the interviewee ranked the success of the projects, not just on functionality but also if they were able to draw attention to green infrastructure and help educate the public (see Appendix B, 2.6).

Ultimately, maintenance seemed to be the biggest project concern and most widespread challenge throughout the state both in terms of education and understanding as well as in who is responsible for completing it. Maintenance was deemed more successful when it was discussed during the design stages and when people were more familiar with the type of landscaping. Underground utility lines, abandoned basement foundations, and soil contamination were all additional challenges that were faced around the state. Projects were considered more successful when there was strong communication and when the public was engaged.

3. Most Challenging Parts of Implementation

Several of the project specific challenges discussed above were also listed as challenges of implementation including organizing maintenance, collaborating between many departments, and gaining community buy-in. Maintenance and lack of staff education continue to be a difficult aspect in regards to green infrastructure. Six interviewees discussed maintenance (see Table 6), predominantly in ensuring that someone was responsible for regular maintenance and that they knew how to do that maintenance or installation correctly. Some of the new topics that were introduced as challenges were policy and funding, policy referring to city codes, ordinances, and regulations. Three interviewees felt that policy was a problem when trying to implement green infrastructure, two of them from Cincinnati and one from TMACOG, yet four interviewees felt that policy was not a barrier to implementation. Funding did not appear to be a major challenge, as many of the departments get their money from ratepayers (local residents that pay into a stormwater fee) while the rest rely on a variety of grant funds.

Table 6: Frequency of Implementation Challenges

Reoccurring Ideas	**Number of Times Mentioned in Responses**
Not sure the percent of city or regional budget that goes towards green infrastructure	8
Maintenance	6
Funding comes primarily from ratepayers	5
Policy is not a problem	4
Policy is a problem	3
Not having educated staff	2
Green infrastructure is not viewed as stormwater infrastructure	2
Requires a lot of department coordination	2

When asked about policy concerns, four interviewees felt that policy was not a problem for their departments in terms of green infrastructure implementation and three of them did. The Cincinnati Office of Environment and Sustainability determined that while the appreciation of green infrastructure is becoming stronger and the efforts to implement more projects are increasing, partly due to more climate disruptions, there are still policy challenges that limit them (see Appendix B, 3.1). For example, surface parking lots are required with new construction, however there are not always considerations towards how the parking lots impact stormwater infiltration. This can sort of reverse or negate the successes of green infrastructure that has been installed in other areas. The Cincinnati Parks Department interviewee explained that their policy needs to be updated and while they have completed projects, they have to sort of 'drag' the Department of Transportation along with them.

The interview with the Ohio University Office of Sustainability also had an interesting perspective of explaining that the policy and procedures are not the problem, it is a matter of priority. More specifically, getting the approvals to follow those procedures and actually implement the projects has been a challenge. In contrast, the interview with the Columbus Department of Public Utilities revealed that their Blueprint Columbus program uses green infrastructure as a way to be in compliance with EPA combined sewer requirements. So their agreement with the EPA is giving them the authority to implement green infrastructure projects. Additionally, because they are self-funded through storm and waste water ratepayers and the city code allows them to install these projects, they do not necessarily have to worry about policy barriers (see Appendix B, 3.2).

In terms of funding sources for green infrastructure, ratepayers and grant funding seemed to be the largest contributors. One specific funding source that was listed several times by the

cities near Lake Erie, was the Great Lakes Restoration Initiative. In many of the interviews, funding did not seem to be a major problem and was not frequently introduced in either the specific project challenges or in the general challenges to implementation. One funding related question that nearly all of the interviewees struggled to answer related to an estimate of the percent of the yearly city (or regional) budget that went towards green infrastructure implementation. The guesses ranged from small amounts, to under five percent, to under ten percent and the Cleveland Mayor's Office of Sustainability confirmed it was less than one percent. Some of the confusion was generated because the interviewee did not have a good grasp of the entire city or regional budget or because the costs for green infrastructure are spread out over multiple years so the exact amount is difficult to quantify.

Both Toledo entities that were interviewed, the Division of Environmental Services and TMACOG, brought up larger issues that affect their funding levels (see Appendix B, 3.3 and 3.4). They expressed concerns that their green infrastructure projects were being looked at as gardens or parks and not truly being regarded as stormwater management systems. Therefore, they were not getting the appropriate infrastructure-level funding for the maintenance of these projects. The interviewees determined that additional outreach and education were needed to solve this problem, both at the government level as well as for the general public.

While long-term maintenance and community support continue to be concerns for many departments, additional obstacles of implementation include policy barriers and limited funding. Some city policies allow green infrastructure and some need to be updated, especially as the demand for green infrastructure grows. Others cities need a shift in priorities and making sure that green infrastructure projects get the necessary approvals. Finally, a major barrier for the

Toledo area is making sure that green infrastructure is recognized as stormwater infrastructure and gets the appropriate funding.

4. Functionality

When asked if their green infrastructure projects are functioning as intended, nearly all interviewees, eight out of nine, confirmed that a majority of their projects were (see Table 7). The success of a project came down to the construction and the maintenance of the project, more specifically, making sure that the people doing the work were properly educated and comfortable with green infrastructure. Three of the interviewees explained that they continue to learn and tweak their standards as they do more of these projects, whether that is in terms of their maintenance plan, design standards, or hiring and contractor specifications. Lastly, the interviewee from the Cincinnati Office of Environment and Sustainability brought up the challenge of competing priorities and how that has impacted the success of their projects.

Table 7: Green Infrastructure Functionality

Reoccurring Ideas	**Number of Times Mentioned in Responses**
Most projects are functioning	8
Maintenance	5
Unexpected materials in the ground	3
Continue to learn and keep tweaking process	3

As the interviewee from the Cleveland Mayor's Office of Sustainability explained (see Appendix B, 4.1), maintenance is essential in keeping green infrastructure projects functioning the way that they should. For instance, making sure that any trash collected in the system is picked up so the project can drain correctly, as was discussed in the interview with TMACOG. Or confirming that the correct, native plants are growing so that the green infrastructure

continues to process water as designed, as explained in the interview with the Cincinnati Parks Department. Along with that, the Toledo Division of Environmental Services interviewees discussed how important it is that the maintenance staff is aware of the plant height specifications for each system and does not simply mow down an entire project.

However, sometimes if the project has not been installed correctly, proper maintenance will not make it work. The interviewee from the Ohio University Office of Sustainability in Athens talked about one of their underperforming projects where the construction team compacted the soil and now the project does not absorb any water (see Appendix B, 4.2). If the construction team does not know what they are doing or does not fully understand how the green infrastructure project is supposed to function, they can install it incorrectly. As noted in the Athens interview, once there are complications during construction, the finished project is likely to have further problems or may not even function, like in this situation. The NEORSD has had similar experiences where the projects may not have been installed correctly and might have caused some of the current maintenance problems. The department now ensures that an inspector is on site to make sure each project is built properly and if there are problems in the future, they will have a better idea of what went wrong (see Appendix B, 4.3).

The NEORSD is not the only department making an effort to learn and adjust their green infrastructure management systems. The Cincinnati Office of Environment and Sustainability interviewee discussed that when it comes to green infrastructure, they continue to learn. Many of their project mistakes or mishaps were due to a lack of maintenance which caused the projects to not function as well as intended and have ultimately made the community wary of future projects. The interview with the Columbus Department of Public Utilities revealed that they continue to alter their design standards as they learn in the field. For example, some projects

were having issues with erosion and so the department adjusted the projects to include rip-rap or stones to slow the flow of water and reduce the amount of erosion.

In the interview with the MSDGC, there were complications of hiring the right construction companies. Because they are a sewer district, many construction companies would just assume the project involved traditional gray infrastructure pipework and were not properly educated about green infrastructure or its components, which resulted in installation complications. The Department has altered their specifications to make sure that in the future, more informed companies are hired and that there are more inspections in place to ensure the projects are installed correctly (see Appendix B, 4.4).

The interview with the Cincinnati Office of Environment and Sustainability brought up the unique concept of competing priorities across the city. So for example, the Cincinnati Street Tree Program has been very successful and has provided numerous benefits, however, urban trees can add to sidewalk deterioration which then impacts ADA Accessibility and their requirements (see Appendix B, 4.5). These situations can create tension between departments and make the results of green infrastructure related decisions more complicated.

The majority of projects are functioning as intended, however there are certainly some complications due to improper construction and maintenance. Some departments continually learn from these obstacles and adjust their projects to be more successful in the future. Additionally, other departments are recognizing the impacts that these green infrastructure projects are creating on the city as a whole.

5. Ownership of Green Infrastructure Projects

As briefly mentioned above, not having clear designations as to who owns these green infrastructure projects creates complicated situations, especially in terms of who is responsible for maintaining that infrastructure. Some departments felt strongly that the city should solely be responsible for maintenance whereas others felt the property owners should always be responsible, regardless of if it was residential or not. There are numerous entities responsible for implementation and maintenance of green infrastructure across the state, as can been seen in Tables 8 and 9 which show the departments that were listed at least twice throughout all the interviews. Although possibly inefficient, several interviewees saw the value in having multiple entities associated with green infrastructure.

Table 8: Departments Responsible for Green Infrastructure Implementation

Reoccurring Departments Responsible for Implementation	**Number of Times Mentioned in Responses**
A Combination of Multiple Entities	8
Engineering Services	4
Parks Department	3
Sewer District	2
Soil and Water Conservation District	2

Table 9: Departments Responsible for Green Infrastructure Maintenance

Reoccurring Departments Responsible for Maintenance	**Number of Times Mentioned in Responses**
A Combination of Multiple Entities	7
Private Contactors	4
Public Services or Public Works	2
Parks Department	2

The interviewee from the Cincinnati Park's Natural Resource Management Department explained that their Street Tree Program has been very successful, in part due to a well-established funding mechanism. However, one of the major challenges comes down to ownership of the soil cells (see Appendix B, 5.1). Soil cells help to provide soil depth and support for urban tree growth, in addition to stormwater management benefits. In Cincinnati, sidewalks are typically maintained by the adjacent property owner and the Department of Transportation and Engineering (DOTE) is responsible for constructing in the right-of-way and building streetscapes including sidewalks. So when the DOTE re-constructs a streetscape to install soil cells, the question becomes who owns those soil cells and who is responsible for maintaining them. Is it the adjacent property owner, the DOTE, or the Urban Forestry program that runs the Street Tree Program? The City is still figuring out who owns what, but other locations are in similar situations, including the city of Cleveland (see Appendix B, 5.2) where there is confusion as to who owns the areas in between the sidewalks and the larger sewer connections. Does it belong to the Division of Water Pollution Control or the NEORSD? This unanswered question creates larger problems when it comes to maintaining or repairing that property and determining who pays for it.

Another maintenance ownership complication has been if residential property owners should be able to maintain green infrastructure assets and both the Toledo Division of Environmental Services and the Columbus Department of Public Utilities say no. They determined that residential property owners should not be responsible for maintenance, but that the City should be, even if that means contracting the work out to a private landscaping firm (see Appendix B, 5.3). The Toledo Division of Environmental Services explained that even with education, the residents did not fully understand how the projects functioned or how to properly

maintain them, so ultimately it was determined that the City should be responsible and should develop a long-term maintenance plan. Leslie Westerfelt from the City of Columbus stated that these projects are considered to be part of their sewer system and they have specific requirements to follow, like types of plants and plant height as well as making sure the drains are not clogged and the soil is correct. So, they take maintenance of these projects seriously and do not expect residents to contribute just as they would not expect residents to try and maintain traditional gray infrastructure (see Appendix B, 5.4). However, the interviewee from TMACOG expressed that it is more simple and straightforward to have the property owner be responsible for maintenance, whether it is city owned or privately owned.

The majority of interviewees listed multiple entities when asked who was in charge of green infrastructure planning, implementation, and maintenance. However, TMACOG relies primarily on its member jurisdictions to implement their own projects. Additionally, the MSDGC only has one specific entity to maintain all wet weather facilities, the Watershed Operations Division, and the City of Columbus relies solely on private contractors to maintain their green infrastructure projects. Nonetheless, some of the entities that have multiple departments in charge of green infrastructure implementation did not find it more difficult, but did acknowledge some of the inefficiencies. The Cincinnati Office of Environment and Sustainability determined that if each entity can just do their specific part and then move on to the next project, there are also some benefits or efficiencies in that process (see Appendix B, 5.5). The Toledo Division of Environmental Services interviewees even consider it helpful to have multiple departments overlap because it ultimately gets more projects built and put in the ground (see Appendix B, 5.6). The Columbus Department of Public Utilities interviewee reflected that they should have had more conversations and dialogue with other departments during their initial planning process

because now that they are implementing projects, it seems as though they are figuring out deals after the fact (see Appendix B, 5.7).

Most cities have a variety of departments that are responsible for planning, implementing, and maintaining green infrastructure. Some entities, in one way or another, appreciate having multiple departments even if it can sometimes be more inefficient. Furthermore, one city was able to recognize areas where there could have been more collaboration between departments. There were some differing opinions on whether or not residential property owners should be responsible for maintenance, but the reasons against included worries about making sure proper maintenance standards are met and concerns that residential owners are not educated enough at this time to do that proper maintenance.

6. Level of Importance

When asked if green infrastructure was a priority for their community five interviewees answered with yes, three gave answers that were not quite yes or no, and one said no (see Table 10). However, not everyone that said green infrastructure was a priority has definite plans to add more and some that said it was somewhat of a priority do have definite plans to add more.

Table 10: Importance of Green Infrastructure

Department	**Is Green Infrastructure a Priority?**	**Do they plan to implement more?**
Cincinnati Office of Environment and Sustainability	Yes	Somewhat
Cincinnati Parks Department	Yes	Yes

Metropolitan Sewer District of Greater Cincinnati (MSDGC)	Somewhat	Somewhat
Toledo Metropolitan Area Council of Governments (TMACOG)	No	No
Toledo Division of Environmental Services	Yes	Yes
Columbus Department of Public Utilities	Yes	Yes
Cleveland Mayor's Office of Sustainability	Somewhat	Somewhat
Cleveland - Northeast Ohio Regional Sewer District (NEORSD)	Yes	Yes
Athens- Ohio University Office of Sustainability	Somewhat	Yes

Many of the reasons why green infrastructure was considered a priority refer back to resiliency. Leslie Westerfelt from the City of Columbus explained that green infrastructure seems to be a big 'buzz word' at the moment and that people are starting to recognize the benefits of green infrastructure, especially in terms of preparing for the results of climate change (see Appendix B, 6.1). The Department definitely has plans over the next thirty years to implement more green infrastructure as part of their Blueprint Columbus green infrastructure program. The NEORSD also considers green infrastructure to be a priority because of its association with improving resiliency. While their department is technically done with the consent decree requirements, they are always looking for other opportunities to add more

projects. Additionally, their Green Infrastructure Grant Program will continue to fund green infrastructure projects throughout the community and has eight more installations planned for this year.

The Cincinnati Parks Department and the Cincinnati Office of Environment and Sustainability both consider green infrastructure to be a priority, but only the Parks Department has definite plans to implement more. The Parks Department interviewee attributed green infrastructure's importance to climate change and how the community expects to prepare for those impacts (see Appendix B, 6.2). The Department mainly plans to implement more urban trees and soil cells over the next few years and especially when they have a stronger maintenance plan in place. The Cincinnati Office of Environment and Sustainability determined that green infrastructure is a priority, however their department does not actually do implementation, so they have set targets for other departments to add more. The interviewees from the MSDGC said they are going to focus on strengthening their maintenance plans and making sure their current projects are functioning correctly. They also discussed that green infrastructure in Cincinnati is very site specific and can be difficult to implement due to both geology and geography, so because of the soil types and the many hills (see Appendix B, 6.3). Ultimately, they determined that green infrastructure is not always a viable option for them and that their main goal is reaching the requirements of their consent decree. Although, they did acknowledge that they had room to improve on their awareness of green infrastructure in terms of keeping it an option for stormwater management (see Appendix B, 6.4).

The interviewees that were marked in Table 10 as having somewhat of a priority were ones that keep green infrastructure in mind, but not necessarily as a main focus. Whether that was because they felt that had a strong partnership with another entity that considers green

infrastructure to be a priority as the Cleveland Mayor's Office of Sustainability interviewee said in reference to the NEORSD. Or whether green infrastructure is one of many priorities, but not necessarily the top one due to limited resources, like in Athens. Although, the interviewee from the Ohio University Office of Sustainability revealed that the city has plans to redo one of their main streets and is going to add green infrastructure along the sides. Like many of the locations, the Toledo Division of Environmental Services said that they will continue to find projects to implement as more opportunities become available.

TMACOG is a regional entity that serves surrounding local governments and its focuses are dependent upon the local governments' interests. So as Kari Gerwin discussed, there was not a lot of attention going towards green infrastructure and no one was really asking for resources, so the Council of Governments (COG) is not concentrating on it as a priority anymore (see Appendix B, 6.5). Also, the COG does not usually do implementation, so even though they installed several projects in the past that is not something they are looking to do in the future. The COG will continue to provide resources regarding green infrastructure to their member communities if that is something they ask for in the future.

It seems that most entities will keep green infrastructure in mind as an option and if there is funding and the right opportunity, they will install it. A majority of interviewees consider green infrastructure to be a priority for their departments and have plans to implement more projects, whether those are definite plans or more of a general goal for the future. Only one department said it was not a priority and that was predominantly because the government members of TMACOG are not currently interested in green infrastructure, however there is still potential that they could become interested in the future.

7. Public Support and Engagement

Most departments felt that they had a moderate level of public support and a few even considered community support to be high (see Table 11). No department felt there was no public support, but many did acknowledge there while there is support, there is also some pushback. The interviewees felt that community members have many different reasons for and against green infrastructure but the most common reasons in favor of green infrastructure were for improving resiliency and water quality and for a connection to a larger environmental issue (see Table 12). The most common reason against it was aesthetics, or how visually appealing the projects look (see Table 13). The departments that were interviewed have a variety of ways to keep the public engaged in green infrastructure (see Table 14) and there may be some sort of relationship between the communities that have more education and outreach events and the level of community support. However, as several interviewees mentioned, they make efforts to educate the public, but there are difficulties associated with that.

Even though the level of public support in many of the communities appeared to be moderate, six interviewees stated that their communities were asking for more green infrastructure type projects (see Table 11). Both interviews with the Cleveland Mayor's Office of Sustainability and the NEORSD mentioned the Green Infrastructure Grant Program and how its success shows that people in the community want green infrastructure and are willing to install it. Both entities also said that there is room for additional green infrastructure education in the community. The NEORSD interviewees felt that people will be more comfortable with green infrastructure when they are able to see its long-term benefits and functionality. They also noted that as long as the Department answers the community's questions and addresses their concerns, they have been supportive. The Cleveland interviewee also stated that aesthetics are an important

factor and there needs to be more education towards why the projects look the way they do in order to gain more community support.

Table 11: Amount of Public Support for Green Infrastructure

Department	**Level of Public Support**	**Is their community asking for more green infrastructure?**
Cincinnati Office of Environment and Sustainability	Moderate	Yes
Cincinnati Parks Department	Moderate	Yes
Metropolitan Sewer District of Greater Cincinnati (MSDGC)	Moderate	Somewhat
Toledo Metropolitan Area Council of Governments (TMACOG)	Moderate	No
Toledo Division of Environmental Services	High	Yes
Columbus Department of Public Utilities	Moderate	Somewhat
Cleveland Mayor's Office of Sustainability	Moderate	Yes
Cleveland - Northeast Ohio Regional Sewer District (NEORSD)	Moderate	Yes

Athens- Ohio University Office of Sustainability	High	Yes

The interview with MSDGC brought up an interesting situation where the community had asked for more projects and was receptive to green infrastructure until they realized they would have to maintain it and would lose space in the right-of-ways. As the interviewees noted, the community wanted to add more natural surroundings without giving up their space. Also, interviewees brought up that sometimes community members would ask to add green infrastructure to projects, but would ask too late in the implementation process so it could not feasibly be added. The Cincinnati Parks Department interviewee estimated that only around thirty percent of the community understood what green infrastructure was but that if they understand its purpose and relevance, they usually support it (see Appendix B, 7.1). Also a connection to larger environmental issues can help gain support for green infrastructure (see Table 12). Cincinnati has a lot of hills and therefore also can have landslides, so the public tends to be aware that adding vegetation can help stabilize land. Other departments also felt that public support towards green infrastructure implementation was based on knowledge of local environmental issues, like the Lake Erie algae blooms in Toledo and the floodplain concerns in Athens.

Table 12: Frequency of Reasons for Green Infrastructure

Community Reasons for Adding Green Infrastructure	**Number of Times Mentioned in Responses**
Resilience	3
Water Quality	3

Connection to larger environmental issues	3
Pollinators	2
Trash Collection	1
More nature	1

Several communities listed trash buildup as a reason against green infrastructure, however Leslie Westerfelt from the City of Columbus had a different perspective (see Appendix B, 7.2). The City of Columbus will clean the trash out of the projects at least once a month as part of their regular green infrastructure maintenance. So for communities that have a lot of trash, it means that the trash is getting picked up once a month, which can therefore help improve the visual aesthetics of the neighborhood. Alternately, for some of the cities that already have maintenance concerns, regularly cleaning up trash that gets collected in the projects just adds more work.

In addition to trash build-up, other reasons against green infrastructure include space, cost, safety, maintenance, and aesthetics (see Table 13). Green infrastructure takes space to implement and although that space is typically in the right-of-way, people sometimes consider that area to be theirs (see Appendix B, 7.3). There also tends to be a Not In My Backyard (NIMBY) aspect to some of these projects, as explained in interviews with the departments in Columbus and Athens, where people do not necessarily have a problem with green infrastructure being installed in other locations, but are not accepting of it being installed in their space.

Also, these projects can be expensive for the city to implement and may not always be a priority when they need to put money towards more pressing needs, like affordable housing or food pantries (see Appendix B, 7.4). In terms of costs to the community, some locations have a

stormwater fee and some cities have increased that fee to fund green infrastructure projects. Some residents may oppose green infrastructure because of the associated fee increase, whereas others have taken it upon themselves to install green infrastructure so they can get credit towards their stormwater fees (see Appendix B, 7.5). Many of the communities also had concerns about safety, more specifically, concerns about illicit activities happening behind tall grasses and standing water leading to drowning and mosquito growth (see Appendix B, 7.6 and 7.7).

Table 13: Frequency of Reasons against Green Infrastructure

Community Reasons Against Adding Green Infrastructure	**Number of Times Mentioned in Responses**
Aesthetics	4
Safety	3
NIMBY	2
Space	2
Stormwater Fee	2
Trash	2
Cost	1
Maintenance	1
Mosquito Growth	1

Maintenance, again, is a recurring concern for green infrastructure projects, but not just in terms of functionality. The most common reason for not adding green infrastructure projects was aesthetics. If the projects are not well maintained, they can become overgrown and an eyesore for the community (see Appendix B, 7.8). However, aesthetics are a subjective preference and some people simply do not like the look of the plants that are necessary for green infrastructure

projects (see Appendix B, 7.9). More education could potentially help communities to understand why those plants are important, even if they may not like the way they look.

The interviewees listed a variety of ways in which they educate and engage with the community. The most common were workshops, social media, community meetings, and signage (see Table 14). Although many efforts have been made to inform the community, several participants noted that they were not sure how much the public actually retained what was said (see Appendix B, 7.10 and 7.11). As Leslie Westerfelt from the City of Columbus said, green infrastructure is not always the easiest concept to understand, especially when people are not really engaged or interested (see Appendix B, 7.12). So Leslie explained that the Department of Public Utilities tries to break down the information into 'bite-sized' pieces so people can learn a little bit at a time. The Cincinnati Office of Environment and Sustainability participant clarified that the MSDGC does most of the outreach and education and that they primarily go to community meetings. There are also training programs, however, the interviewee articulated that this is not necessarily public education because it may not be reaching everyone in the community, just the people that are interested enough to attend (see Appendix B, 7.13). Ian Laseke from MSDGC further explained that while not everyone may be attending these meetings, the Department hopes that the people that do come help communicate to others the benefits of green infrastructure (see Appendix B, 7.14).

Table 14: Frequency of Types of Public Engagement

Types of Public Engagement	**Number of Times Mentioned in Responses**
Workshops	5
Social media	4

Community meetings	3
Signage	3
Attending festivals or events	2
Pre and post construction meetings	1
Project tours	1
Summer camps	1
Education in schools	1
Technical Conferences	1

Because some departments invest more effort into trying to engage or educate the community, it was interesting to see if they received more public support as a result. As Table 15 shows, this was not necessarily the case. While some departments have a high level of community engagement and a high level of public support, like the Toledo Division of Environmental Services and the Ohio University Office of Sustainability, that does not apply to all. It was also intriguing to see that some departments with low levels of engagement, that are not doing as much to educate the public, still have moderate levels of public support.

Table 15: Comparison of Community Engagement to Levels of Public Support

Department	**Level of Public Support**	**Effort to Engage Community**
Cincinnati Office of Environment and Sustainability	Moderate	Low
Cincinnati Parks Department	Moderate	Low

Metropolitan Sewer District of Greater Cincinnati (MSDGC)	Moderate	Moderate
Toledo Metropolitan Area Council of Governments (TMACOG)	Moderate	Low
Toledo Division of Environmental Services	High	High
Columbus Department of Public Utilities	Moderate	High
Cleveland Mayor's Office of Sustainability	Moderate	Moderate
Cleveland - Northeast Ohio Regional Sewer District (NEORSD)	Moderate	High
Athens- Ohio University Office of Sustainability	High	High

Each community has different ranges of community support, most of them are at a moderate level where there is some support but also some pushback. Only two departments confirmed that they had high levels of community support and both of these departments also had a higher focus towards community engagement. While other entities also made more of an effort to educate the public, they did not necessarily get more public support. There are a multitude of ways that the different departments engage with the public, but the most common were workshops and social media. The different communities also had a variety of reasons for and against green infrastructure, but the most frequently mentioned ones in support of it were for increasing resilience, improving water quality, and understanding the impact of larger environmental issues. The most repeated reason against green infrastructure was aesthetics and

making sure that the projects look appealing. Several entities came to the conclusion that the more the local community was educated and the more they understood green infrastructure, the more they seemed to accept it.

8. Education of Elected Officials

Not only are cities making an effort to educate the general public, many of them are also educating elected officials and administrators. Five departments are working to educate their officials, two are not because they feel their officials are already informed enough, and one said they were not educating their officials, but should because they are not fully informed (see Table 16). The ways that each department educates their officials varied, including bus tours, presentations, an in-depth training of the sewer system, meetings, and workshops (see Table 17).

Table 16: Education of Elected Officials

Are Elected Officials being Educated?	**Number of Times Mentioned in Responses**
Yes	5
No, because they are already informed	2
No and they need more education	1

Table 17: Frequency of Ways Public Officials are Educated

Ways of Educating Elected Officials	**Number of Times Mentioned in Responses**
Workshops	2
Meetings	2
Bus tours	1
Presentations	1
Training	1

The Cleveland Mayor's Office of Sustainability and the Athens Ohio University Office of Sustainability participants felt that their elected officials and administrators were informed enough about green infrastructure to include it in decision-making and therefore did not need further education. The participant from Cleveland explained that the elected officials are aware and it comes back to just finding the right opportunities and resources. One department expressed concerns that while their elected officials know what green infrastructure is and support it, they are not always aware of its limitations, so they want to add it in situations where it may not be feasible or successful (see Appendix B, 8.1). Therefore, the participants felt further education to explain those limitations would be beneficial, even if it is not currently happening.

The departments that are currently working to educate their local governments have used a variety of methods. Kari Gerwin from TMACOG described how the COG took a group of elected officials on a bus tour to show them examples of green infrastructure projects (see Appendix B, 8.2). Both TMACOG and NEORSD participants stated that there are also workshops available for elected officials and administrators. The Columbus Department of Public Utilities has provided presentations exclusively for City staff on green infrastructure as well as a comprehensive training called Sewers 101, which explained the entire sewer system and how their efforts would change it. They also keep City staff updated by going to staff meetings. The Cincinnati Parks Department interviewee said they have been meeting with the mayor to explain their projects and some of the obstacles they have been facing. The meetings have been successful and the mayor has begun to understand and speak toward these issues, which is a 'point of pride' (see Appendix B, 8.3).

Ultimately, the education of elected officials and administrators will help them to make more informed decisions regarding green infrastructure. A majority of departments are working to educate their officials through workshops, presentations, bus tours, meetings, and other trainings like Columbus's Sewers 101. Two departments feel their elected officials are already informed and do not need more education, yet one department thinks their elected officials could benefit from more instruction especially regarding the limitations of green infrastructure.

9. Additional Factors

While not a specific component of this research, one department, MSDGC, did present an interesting point about how political affiliation can sometimes correspond to an overall attitude towards green infrastructure (see Appendix B, 9.1). Both participants also discussed some of the challenges within their community, like how it is difficult or complicated for them to say 'climate change' and instead they refer to it as 'extreme weather' (see Appendix B, 9.2) and further, how the impacts of extreme weather are leading to increased flooding.

Chapter 5: Discussion and Conclusion

Referring back to the original question of: What kinds of green infrastructure are cities in Ohio implementing and what are the possible barriers to implementation? The kinds of infrastructure focused specifically on green stormwater infrastructure and the projects listed include permeable pavement, bio-retention cells/bio-swales, green roofs, rain gardens, rainwater harvesting, tree canopy, and soil cells. Additionally, these green infrastructure projects provide the specific benefits of carbon sequestration, tree canopy coverage, water quality improvement, green space or habitat construction, reduction of greenhouse gas emissions, rainwater harvesting,

and re-use of stormwater. Some of the most important aspects of green infrastructure projects throughout the state were that they infiltrate and purify water, while also reducing the total amount of stormwater runoff going to combined sewer systems.

The possible barriers to implementation include maintenance, community support and education, limited funding, and policy. Maintenance proved to be one of the biggest challenges for cities, especially when determining who was responsible for completing it, as well as making sure that they understood the systems and how to properly maintain them. There was also some debate as to whether or not residents should be expected to maintain green infrastructure projects on or adjacent to their property and if they have enough understanding of these projects to do so. Participants considered projects to be more successful when maintenance was planned during the design stages and when there was more communication between necessary departments.

While the majority of projects across the state are functioning as intended, there were some complications during construction that led to projects underperforming. Some of these complications included finding objects in the ground that were not expected to be there, for instance underground utility lines, abandoned basement foundations, and in some cases, soil contaminants. Although, the more frequent complication with construction was uninformed contractors. There were several cases where the contractors that were hired did not have an understanding of the green infrastructure project they were building and constructed it incorrectly. For example, with NEORSD where the catch basins were built at grade, instead of above grade and in Athens where the soil was compacted and therefore could not absorb the water it was supposed to. The solution that the NEORSD participants utilized was to make sure that there is someone on site during construction that is familiar with these types of projects and knows how they should be installed.

A lack of community support towards green infrastructure could be a potential barrier to its implementation. While each department had at least some support for these projects, they also had some pushback. The most common reasons for green infrastructure came from residents wanting to improve the resilience of their community and improve water quality. Larger environmental issues like landslides, algae blooms, and flooding also had an impact on increasing public support of green infrastructure. The predominant reason against green infrastructure from the public was aesthetics. While some of that, again, goes back to maintenance and ensuring the upkeep of projects, it also goes back to community education and making sure that people understand why certain plants are being used and what the benefits are. Multiple participants felt that the more the public was educated, the more supportive they were for these projects, however that did not appear to be true for all departments. Some locations had high levels of community outreach and education and also had high levels of public support, yet other locations had high levels of engagement, but only had moderate levels of support. Perhaps that goes back to the challenge of trying to educate a community that may not be interested or listening.

While funding and policy were not as big of barriers as anticipated, they were still a challenge for some communities. The main obstacle in regards to funding was that green infrastructure was not considered to be part of the stormwater management system, but instead was thought of as parks or gardens. So, the projects were not getting enough funding to allocate for maintenance and upkeep of the projects, especially in comparison to other more traditional infrastructure systems. Increasing education for the public about green infrastructure can help more people to realize that while it has plants similar to parks or gardens, it also processes stormwater runoff and drainage like traditional infrastructure and therefore should be considered

as part of the stormwater management system. Although funding did not appear to be a major obstacle for the cities in this study, some areas may simply not have the budget to pay for these green infrastructure projects or have access to grant opportunities, which could become more of a barrier to implementation. Overall, policy was not a major issue for the majority of departments, yet several felt their city polices could be updated. In other words, projects could go forward and be installed, however sometimes it was an overly complicated or difficult process.

Most of the locations in this study are considered to be medium to large cities, aside from Athens. It was interesting to see if a smaller city would have some of the same issues as larger cities, and for the most part they did. Maintenance determinations continued to be a challenge, however at Ohio University a Memorandum of Understanding stating who is responsible for maintenance and repairs is required before the project can be approved. Additionally, the City has had challenges with contractors not being educated about green infrastructure. There seemed to be high levels of both community engagement and community support in Athens, which was not as common in larger cities. Yet, even though the elected officials were considered to be educated about green infrastructure and policy was not a major roadblock, green infrastructure was not a top priority for the community but rather one of many priorities that will be implemented as more opportunities and resources become available. This mindset towards green infrastructure implementation as somewhat of a priority existed in some of the larger cities as well.

While not a major focus of this research, the MSDGC participants did bring attention to another potential barrier to implementation, which is a community's political affiliations or overall opinions towards climate change. If a community does not recognize the impacts that increased precipitation will have on their city and only associates these heavy rain events with

‘extreme weather,’ they may not see a need for adding projects like green infrastructure and therefore may be opposed to it.

There were some additional factors that were expected to be barriers to implementation but ultimately did not seem to be major obstacles for the departments interviewed. These include the number of departments in each city that are responsible for implementing projects, the education of elected officials, and the overall priority of green infrastructure. Unsurprisingly, many departments acknowledged that having several entities in charge of implementation could at times be inefficient, but overall they felt that having multiple overlapping departments meant more projects would get built. One city recognized that the communication between departments could have been better, especially when they were starting the project, and that it would have been beneficial to plan some of the details out in advance. While having multiple departments made implementation potentially more successful, it seemed to make maintenance more complicated.

Even though the general public seems to need more education regarding green infrastructure, many of the departments were already educating their elected officials or determined they were sufficiently educated. This was unexpected, but ultimately means that elected officials and administrators will be able to make more informed decisions in regards to green infrastructure. Some departments were also educating city staff to make sure they were well-versed in green infrastructure. Having decision-makers aware of green infrastructure and its benefits seems like an asset to implementation instead of a barrier.

Unexpectedly, many departments considered green infrastructure to be a priority for them and have at least general plans for implementation in the future. While some departments have

specific goals and targets for more projects, others are keeping green infrastructure as an option and if the right opportunity becomes available they will implement it.

In summation, green infrastructure seems to be a priority throughout most of Ohio and it is likely that projects will continue to be installed. The most prominent barrier to implementation is maintenance, specifically in terms of knowing who is responsible for maintenance, making sure they understand how to properly maintain the projects, and confirming that the maintenance is completed. There are also similar barriers in construction, again in making sure that the contractors understand the projects they are building and install them correctly. Public support, both from the community as well as the elected officials can aid in project implementation, as long as they are educated and understand the functions of green infrastructure. People seem to be aware that green infrastructure can help improve the resiliency and water quality of their community, but are also very mindful about the aesthetics of the projects and ensuring that they are visually appealing. Policy and funding do not appear to be major obstacles, however some city policies need to be updated. Finally, in funding determinations, green infrastructure should be regarded as part of the stormwater management system to ensure that there is adequate funding to complete proper maintenance.

As for recommendations to make green infrastructure projects more implementable and successful, there could be more established maintenance plans, increased requirements of contractors, specific community engagement plans, and established aesthetic guidelines. For every green infrastructure project that is designed and expected to be implemented, there should also be a maintenance plan in place that explicitly states who is responsible for maintaining each asset. This maintenance plan should be developed by all the relevant entities responsible for both maintenance and implementation of green infrastructure, so there is clear communication among

everyone involved. For both maintainers as well as contractors, there should be some sort of required education or certification that proves they understand how the green infrastructure project functions and how to maintain or install it. The National Green Infrastructure Certification Program (NGICP) is an education and certification system that already exists and is one possible training that cities could require. It would also be useful to provide the contractors with a guide that explains what to do if they face specific complications, like finding unexpected utility lines. As was the case in some cities, more public education and engagement about green infrastructure can lead to more public support. Each City should have some sort of community engagement plan that outlines how they intend to interact with and inform the public about these green infrastructure projects. Finally, with increased education the community should be more aware of why certain plants are chosen for green infrastructure projects. However, the public could be given opportunities to offer input on which of these plants they find to be more visually appealing. With this information, perhaps the City could put together a sort of aesthetic guideline that reflects their community's plant preferences. Overall, these recommendations can help reduce the barriers to implementation for green infrastructure projects.

Limitations and Reliability:

Due to time constraints, a limited number of locations were selected and a limited number of interviews took place. Had there been more time available, more places and people could have been included within the study, which would have helped to form a more in-depth assessment of the state. Ideally, there would have been more interviews within each location and also more interviews over time to follow-up on progress, but that is not a possibility for this specific project.

The data collected for this study was gathered in an ethical way with completely voluntary participation, password-protected data, and no deception to participants or anyone involved. With the consent of the participants, the interviews were recorded to maintain accuracy and they were asked if they wanted their name and position to remain anonymous. The interviewees were expected to represent only information relevant to their city or department and no personal questions were asked. The participants were allowed to abstain from any of the questions and could exit the study at any time.

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Appendix A:

Interview Questions:

1) What are the criteria that your department uses to distinguish a project as green infrastructure?
2) Of the projects that have been implemented so far, which has been the most successful? Why?
3) What project has been the most challenging? Why?
4) Are the majority of projects that have been implemented functioning as they were intended? Have there been many complications either during construction or after the project has been built?
5) What would you say are the most challenging parts of implementation?
6) What are your department's top 3 funding sources towards green infrastructure? Does your department use funding from the local, regional, state, or federal levels? From the private sector?
7) What would you estimate is the percent of the yearly city (or regional) budget that goes towards green infrastructure implementation?
8) Is your department the only entity in charge of planning and implementing green infrastructure projects?
9) Who is in charge of maintaining or repairing green infrastructure projects?
10) Would you say green infrastructure is a priority for your department and your community? Why or why not?
11) What would you estimate is the level of public support? What are some of their reasons for or against green infrastructure?
12) Has the community asked for more of these types of projects?
13) Has there been community support for the projects that have been implemented so far?
14) Has the community been educated about green infrastructure and the pros and cons of its implementation? How does your department engage with the public about green infrastructure projects?
15) Does your department have plans to implement more green infrastructure projects in the future?

Appendix B:

Interview Quotes:

1.1 "Green infrastructure means stormwater quality or quantity BMP's [Best Management Practices] that provide a function in addition to stormwater management, such as water reuse, providing green space or habitat in the city, and/or reducing greenhouse gas emissions…We have to make sure that the green infrastructure is something that is actually serving that function rather than just being a permeable surface." – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

1.2 "A lot of practices we sort of realized, yeah maybe they offered some water quantity benefits, where they managed a quantity of water, but they didn't necessarily have a water quality benefit. So that's sort of the way we were looking at it was are these practices just managing the amount of water or are they also providing some infiltration that offers a water quality benefit." – Kari Gerwin, Director of Water Quality Planning at TMACOG

1.3 "The main focus being increasing the resiliency of our combined sewer system by removing stormwater runoff from that system." - Chris Hartman, Stormwater Technical Specialist at NEORSD

2.1 "One that we have seen the most success from…is the infiltrating one. Specifically, bio retention and the reason being because the owner of the property really is the responsible party that maintains these practices. So the success has been due to the fact that there's less of a learning curve to maintain a bio-retention cell and other types of practices because the majority of the maintenance is simply related to the top of the practice, which is the landscaped component. So it's maintaining the landscaping much as they maintained any other landscaping that they had or have on the site as well… we fund lots of different types of permeable pavement systems and we have seen some challenges with those when their maintenance is required by the owner of the property. Again, exactly opposite of bio-retention, there's a much greater learning curve of how to maintain this different type of parking lot system. So it takes a lot more TLC, if you will, to keep it functional and it's something that most of the property owners are not used to and therefore it gets neglected more than others." - Chris Hartman, Stormwater Technical Specialist at NEORSD

2.2 "I would say the most challenging parts are contractors who are unfamiliar with the construction of these practices. It's a new technology for some, certainly the more we build, the more contractors gain the experience and things do improve year after year. A good example would be… I assume you're familiar with what bio retention cells are, what they generally look like, but so the big, the very distinguishing feature of a bio retention cell is that the outlet structure, typically centered in the cell, is 6 to 12 inches above grade. Contractors that aren't familiar with these things don't comprehend that. Everything has got to be at grade, why is this catch basin sticking out of the ground like it is? So, they overfill the bio retention cell and now

we don't have any storage volume. That's been something we've had to overcome, but we've made efforts to eliminate that problem since." - Chris Hartman, Stormwater Technical Specialist at NEORSD

2.3 "I think from the operations side, the most successful projects are the ones that have good communication between the design and the maintenance. We have got projects handed over to us that aren't completely maintainable and so that lends itself to being not maintained and in the end a lot of the useful life is decreased significantly... So, I think that the most successful projects are the ones that are designed for maintenance because they can and will be maintained." - Leslie Schehl, Supervising Engineer at MSDGC

2.4 "Another challenge with that, is the fact that you don't know that people hate something, usually until it's in the ground. We had a lot of public meetings trying to get people's opinions on this, trying to figure out, you know, what do you like what do you not like, etc. The fact of the matter is people don't come out or engage with the government unless there's something happening that they don't like…cities can spend a lot of money trying to design something that will be acceptable to residents and if they're not getting feedback during that design process and enough feedback, then it's kind of like shooting in the dark, you know?" – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

2.5 "I would say that of those types of projects where were actually working in neighborhoods, the more successful ones were ones where the community and the adjacent neighbors were actually involved in the process." – Kari Gerwin, Director of Water Quality Planning at TMACOG

2.6 "in terms of public awareness and education, our green roofs have been really successful at raising awareness of why you want green infrastructure and why it's important." – Ohio University Office of Sustainability in Athens

3.1 "I think we are rapidly realizing the severity of some of the climate disruptions we're experiencing and our appreciation for the role of green infrastructure is growing. However the pace with which we can install it is limited. Right, we have 200 years of city development without a strong consideration for green infrastructure and now we have to actively undo some of that. To make matters worse, we have policies that compete with us, I guess, you know, when you're required to install surface parking lots for new construction, you know if there isn't careful thought given to stormwater infiltration for those parking lots then you can be undoing good work you're doing in other places." – Cincinnati Office of Environment and Sustainability

3.2"There's no policy per say that is granting us the authority to do this work. We create a city code that made it allowable, but beyond that because we're self-funded, nobody's really going to be able to come in here and say you have to stop doing this. The other thing also is the way that we've structured our green infrastructure policy and especially with Blueprint, which is 30 years. Now that we've started down this path, we can't really all of the sudden, like if there were a new

mayor that came in tomorrow and campaigned on this platform of, 'I'll get rid of Blueprint,' well, you can't really do that because then we would be in non-compliance with the EPA. At this point, now that we've started down this path and said, 'we're not going to do tunnels, we're going to do green infrastructure,' we've started there and you can't go back halfway through and said we'll build half of a tunnel, you know what I mean? So, the policy question, at least here in Columbus, I think that we're really fortunate in that once everybody got on board and decided this is what we were going to do, that's the end of the discussion, this is just happening. – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

3.3 "Kind of like we said before, our most challenging part for the implementation of these things has been the long-term maintenance for the projects. A lot of people, here even in our city divisions and what not, view them just as gardens versus you know storm water maintenance control. So it has taken a lot of education and outreach in order to try to get people on board for maintaining these as infrastructure. So we're hoping to just increase the amount of funding that we can get. We do, you know, have it as a line item in our budget, but we're always pushing for a little bit more because it's hard to get them properly maintained." – Toledo Division of Environmental Services

3.4 "So perhaps you can, you know, get a practice installed, but local governments aren't really looking at green infrastructure as part of their storm water infrastructure, they're looking at it more as like parks and landscaping, so they're not allocating the public works funding that really needs to be allocated to maintain the green infrastructure as part of storm water infrastructure, so that's one of the challenges." - Kari Gerwin, Director of Water Quality Planning at TMACOG

4.1 "Our maintenance has been okay, it could definitely be better and that's really what I've seen is essential for green infrastructure projects, is making sure that you're properly maintaining them so they continue functioning the way that they have." - Cleveland Mayor's Office of Sustainability

4.2 "I'm not sure if that was actually intended as a rain garden or just like a bio-swale, but that one does not, it's showing that it's not absorbing any water so the water just runs off, as if this was an impervious surface. So that complication was introduced during construction because it was compacted by construction vehicles and so therefore it causes complications after you know, right?" – Ohio University Office of Sustainability in Athens

4.3 "We recognized that some of the construction means and methods that were used may have resulted in some of the maintenance problems we're seeing now. So we've made a concerted effort to be on site with an inspector watching...so that we have an exact idea of how it was constructed, and if there is a maintenance problem down the road, that we'll have a much better idea of what might have gone wrong." - Chris Hartman, Stormwater Technical Specialist at NEORSD

4.4 “I will say that the thing that happens the most during construction, that is a problem…is getting the right people. We were getting construction companies bid on our projects that were typical pipe construction people, because we're a sewer department, so they thought any project that comes out of the sewer department is a pipe project and if it was something else, they can learn it on the job….So we’ve learned that over time and changed our specifications for a lot of these projects to include establishment periods and very tight construction admin when it comes to construction inspection. Which has helped a lot to make sure that the soils are correct, to make sure that the rocks are put in correctly. I think that's the probably the biggest problem that we had during construction was just the education of construction people on site.” – Leslie Schehl, Supervising Engineer at MSDGC

4.5 “We also suffer from competing priorities, you know I talk about the street trees program. Street trees has an incredible number of benefits, however they can contribute to the destruction of sidewalks and so, when you’re competing with ADA accessibility for wheelchairs, or trip hazards created, sometimes that can create situations where it pits one department against another or neighbors against each other.” – Cincinnati Office of Environment and Sustainability

5.1 “So again the soil cells are a challenging issue because in Cincinnati, the sidewalks are actually maintained by the adjacent property owner and so in order to install these features, you have to have, somebody basically has to take control of them or have responsibility for them. So in large streetscape projects, the department of transportation and engineering will generally come in and, you know, redo the whole streetscape including sidewalks, but then in order to install the soil cells, we’re still kind of debating back and forth as to who actually owns those assets. Is it department of transportation, is it urban forestry, or is it the adjacent property owner? So that’s kind of been a challenge and one that we have to figure out moving forward” – Cincinnati Parks Department

5.2 “It makes it less efficient, I don’t know if I would say more difficult. It’s just less efficient sometimes identifying who should be working on stuff, so we have in the city a Division of Water Pollution Control which operates everything from basically the sidewalk to the connections to the Sewer District’s larger system. I feel like there’s a lot of gray area between where Water Pollution Control stops and where Sewer District begins. Then when you do have these questions of like, ‘okay, who’s going to pay for this repair,’ that can make it more challenging for sure.” – Cleveland Mayor’s Office of Sustainability

5.3 “This project has sought to identify the need for a long-term maintenance plan that is fully implemented by the city, because of all the education and outreach that we provided before and after the project, many of the residents still didn't have any idea or understand the purpose of the rain gardens, or how they function, or how to care for them. So we determined that this is something that, if we have these projects, the city is going to have to take on the maintenance.” – Toledo Division of Environmental Services

5.4 “We have taken a very firm stance, we actually don’t want residents to be trying to take care of these rain gardens for us. We want to know what plants are in there, we have to make sure that the plants that are in there meet our certain requirements, so we have height requirements on them, they have to be salt tolerant, obviously, since they’re on the road and things like that. Ultimately, if that under drain were to clog or if people are walking on the soil and compacting it, it won’t drain and it won’t achieve its function. So, our stance is, these are part of our sewer system, you wouldn’t go around and try to do your own maintenance on a manhole, don’t do it on these rain gardens.” – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

5.5 “It seems to be the way it most things work, you know, the designer is different than the builder who is different than the maintainer. So yeah I'm sure there's some inefficiencies there, but at the same time some efficiencies. If the designers could shift focus to the next project, that probably makes sense. I think there is also a fairly substantial workforce development component to this. We have nonprofits that are really focused on training people to do green infrastructure maintenance, makes a lot of job creation outside of city government I think that as a positive.” – Cincinnati Office of Environment and Sustainability

5.6 “Because we have so many divisions with different functions, some of them overlap. Maybe you might have engineering services and they plan certain things, but some of their projects may require green infrastructure. But then you have parks and forestry and they plan other things and some of their projects can use green infrastructure. So there's no way, I don't think you can have one department in charge of green infrastructure and getting things in the ground.” – Toledo Division of Environmental Services

5.7 “So, it’s been really interesting in that public utilities came up with the plan to do rain gardens, to manage the stormwater and we told these other departments about it, obviously, but I think if we had involved them a little bit heavier kind of in the development of the plan upfront, then now as we’re actually working in the neighborhoods, now were figuring out a lot of details with them kind of after the fact.” – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

6.1 “I think that as we’re just talking about climate change in general, people see green infrastructure and it’s become this really big buzz word. People see it as a way to develop some kind of resiliency, right, so they’re like, ‘well if you’re already trying to address excess water on the street and if you’re already trying to improve the capacity of your stormwater system and we know that the rain is going to get worse,’ they see this as a way to kind of give ourselves a buffer at least. Obviously, the way that we’re designing the program and doing the rain gardens, is not in anticipation of what rainfalls are going to look like in 50 years, you know, we can’t for a lot of reasons think that far ahead, but it’s something that people are thinking about themselves and saying at least one step in this direction is a good start.” - Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

6.2 “I think a lot of this has come just as, you know, climate change research is coming to light on a more board scale. After, you know, 10 years of reporting that’s been done and the estimates coming to light and kind of living up to what was estimated to impact us, so more rain, more flashy storms, we’re really starting to see earth movement and, you know, contamination of our waterways. So, I think the more that this stuff is in the public, the more people are starting to recognize it, but I think in general, we still have a ways to go to educate the community about the importance overall.” - Cincinnati Parks Department

6.3 “I will say Cincinnati has a very unique geology in terms of clay soils that don't really make it conducive to do a lot of green infrastructure, but that's not typical for all of Cincinnati. So it's really about finding the opportunities where the space is available and the geology's right to kind of get us into, you know, the right parameters for green infrastructure.” – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati

6.4 “So I mean, we could probably do better about making sure we always are cognizant of green infrastructure, but you know our consent decree is complicated and really our goals are kind of end of pipe and when that happens, usually our goals are try to get that done as simply and as quickly as possible, not all the time is green infrastructure a solution.” – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati

6.5 “A lot of what we focus on is very much grant driven, we’re driven by whatever our members would like us to focus on. So if we don't have the grant funding to focus on it and if our members aren't saying ‘hey focus on providing good resources for green infrastructure’ then we're not really going to focus a lot on it. Like I mentioned before, that there was a green infrastructure task force that had formed and so we were meeting very frequently with a lot of sub committees really trying to get some regional momentum for green infrastructure and get more infrastructure and more green infrastructure installed, but it kind of lost, that group really lost speed when we realized that there are a lot of institutional roadblocks and policy roadblocks to I guess really ramping up the way we had hoped.” - Kari Gerwin, Director of Water Quality Planning at TMACOG

7.1 “I think in general, if the person understands what green infrastructure is and what its function is, then they’re generally for it.” – Cincinnati Parks Department

7.2 “The rain gardens are actually kind of ideal for neighborhoods that have a lot of trash in them because the trash will collect in the rain garden. Then our maintenance guys are coming out and cleaning them out once a month and that means that for these neighborhoods, the trash is then off the street and the city is then coming and doing something with it... So trash receptacles is not something that we want the rain gardens to become, but the fact of the matter is they will accomplish that goal.” – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

7.3 “I do think that in terms of projects that the department as a whole has undertaken, Blueprint is definitely one of the more challenging ones. I think the reason for that, kind of similar to why our other projects are more effective when they’re not in residential neighborhoods, is anytime you’re talking about being in somebody’s space, and even if it’s the Right-of-way, even if its city-owned space, when you’re talking residential neighborhoods or those smaller community parks, people view that as their space, you know, they view the area in front of their house as their space.” – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

7.4 “I think another thing with rain gardens and green infrastructure in general though, is it’s not cheap. So, especially for smaller cities that have less of a budget that they can work with, that’s probably, I would assume, one of their larger barriers. Do you have access to the money that you would need for this? Do you have access to the workforce to build these things? Right, because if you don’t have that locally, then you’re bringing folks in; that just keeps jacking your price up, and do you have the local workforce expertise and the money to then maintain them forever?...You know, is it a priority for the community and if we do this, does that mean we can’t, I don’t know, put people in housing or fund food pantries or whatever?” – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

7.5 “I can’t say there’s too many that are necessarily against it, a lot of folks don’t like paying their stormwater fee, that’s for sure. We’ve seen even some private entities that are sort of taking this on and doing their own stormwater installations because they recognize some of the benefits of it as well, both for themselves, getting some credits towards those fees, but also just in general for their contribution to water quality.”– Cleveland Mayor’s Office of Sustainability

7.6 “You know, a lot of the concerns they had prior to these being constructed were about safety: whether these are going to be hiding places for people to do bad things, you know, how deep is the water going to get in some of these features and how long will it be that deep? If it's not a safety issue, is it an issue with mosquito growth; are we going to have lots more mosquitoes because you have open water on some of these GI features? So there are a lot of public perceptions of what would be bad about these practices that people were concerned about.” – Kim Colich, Manager of Stormwater Design at NEORSD

7.7 “I did have a council member say, you know, ‘what about the kids, you know, kind of walking into the water?’ and that was, as I kind of alluded to early on, I went there and I presented. I said look there are detention structures all over Cincinnati that function the same way. I said look this has been operating in this fashion for over 100 years, whether you know it or not, there is a creek behind here and the kids go down there and play there anyways. I said, you know, and I kind of gave them some talking points to say: here's how the system should function, it shouldn't be a risk to the kids, you know, but we don’t want to put a fence around everything because, believe it or not, that actually attracts attention. But you let them know what

the pros and cons are, like yes you are going to see people operating and maintaining it, yes it will have some water in it but it's not going to be there very long, and you let them know that it's actually, hey we're here to help make sure this functions long-term and doesn't degregate in such a way that it, you know, it doesn't function anymore." – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati

7.8 "I think some of it is when it's not maintained correctly, so it's like: oh, it was really pretty at first, but 2 or 3 years later, now it's just another ugly vegetated installation that's full of weeds, nobody knows what's what, and it's also not necessarily serving its purpose; that's when we definitely get a lot of pushback and criticism from the community… Yes, folks and neighbors all have their opinions. We've got folks in the city that have their opinions on what is considered well-groomed versus more of a wild native look. We've had pushback or disputes between neighbors like, 'oh my neighbor just let their grass go and it looks like a total abandoned house or something,' though that person intentionally planted these native plants to bring pollinators to the area. There's definitely a lot of education that's needed around kind of just clarifying why some of these things are so beneficial and getting folks more comfortable when they see them that it's not like someone had just stopped doing their yardwork and didn't care anymore." – Cleveland Mayor's Office of Sustainability

7.9 "So, that aesthetic part of the equation has really been a challenge because meeting the technical requirements of green infrastructure while also making it pretty, is hard." – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

7.10 "We've tried to educate people, so whether the community has actually been educated about that or not, that's a different question, but we certainly have tried." – Ohio University Office of Sustainability in Athens

7.11 "Yes, but they've also been educated about recycling and anti-idling and not-smoking, you know all sorts of stuff. You're going to have the folks that really respond to it, like I find gardeners for example, really get it and appreciate what we're doing because they're using that water and connecting to it in a different way. Folks that go to the lakes more regularly can sort of appreciate like, 'yeah, I've been there when there's a beach closing day,' and if we can help make the connection of why green infrastructure helps reduce those beach closing days, it definitely helps. I think there's a growing awareness, but you're still going to have those pockets of folks that just don't care." – Cleveland Mayor's Office of Sustainability

7.12 "I will say that it's a little bit tricky to get people to give you enough of their attention to really kind of make sure that they're understanding this, right? Nobody wants to talk sewers, certainly, and then green infrastructure is one of those [things] where it's kind of like, 'oh hey cool,' and unless I'm talking about specifically this space that you're standing in, we usually say you've got maybe two minutes to get something across. So, we are trying to do education and then I think also when you're talking about something like this and a city project, and green

infrastructure it's not hard, but it's not necessarily the easiest concept for people to understand. Like what kind of pollutants are you filtering out and how do the plants factor into this and all that kind of stuff, but ultimately, I think repetition is something that is really helpful. So rather than trying to sit people down and give them all of the information at once, which is certainly the easier thing to do, we're trying to create these more bite-size bits of information that we can build on and then hopefully kind of get people understanding it that way." – Leslie Westerfelt, Department of Public Utilities spokesperson for Blueprint Columbus and Stormwater Education

7.13 "Most of the public engagement is led by the sewer district and they frequently go to community meetings to present the work they are doing and the impact. I will say that many of the neighborhoods experiencing these major projects are frustrated by the major construction first for an extended period of time. So it's not always well received at that stage…I think it usually looks like attending ongoing community meetings and presenting on benefits and projects. There are training programs specifically focused on green infrastructure, but there's a cost to them and I don't know that it's truly public education. I think more are people who are interested and getting into the details of it." – Cincinnati Office of Environment and Sustainability

7.14 "So right, we go out there, but usually it's geared towards the community council meetings. As I said, not everyone's always present, usually just those few stake holders who are really involved in the community, but the hope is that they can spread the word and send a positive message about what green infrastructure can do and what the benefits of it are." – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati

8.1 "Yeah, I think it's a double edged sword because we've got champions in high places with not all the information. Well, you know, they see it as a good thing, it's really great, and I agree, but it's got a place and a purpose and so sometimes getting them off of the subject of this project using green infrastructure is harder than getting them to get on board." – Leslie Schehl, Supervising Engineer at MSDGC

8.2 "We had a couple of workshops, well more than a couple, we've had actually quite a few workshops on rain gardens as green infrastructure and just green infrastructure in general, so yeah there has been some education but not incredibly widespread. It's been more targeted, most of the work that we were doing through the Green Infrastructure Task Force was really focused more on educating administrators and elected officials on the importance of green infrastructure and how it can be a more cost effective solution and of course better for water quality…We've done bus tours, so we've got an inventory of all the green infrastructure in the region and we've taken some elected officials and administrators on a bus tour of some key locations; that was pretty effective." – Kari Gerwin, Director of Water Quality Planning at TMACOG

8.3 "To actually start hearing some of the administrators speak to it themselves, so being in a meeting and hearing the mayor explain the importance of green infrastructure or some of the

tools that we have in our toolbox has been very interesting and really a point of pride." – Cincinnati Parks Department

9.1 "The city tends to be more liberal whereas the county tends to be more on the on the conservative side. I'd say that directly matches kind of green infrastructure buy-in" – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati

9.2 "We're not allowed to say the word climate change, so we call it extreme weather." – Leslie Schehl, Supervising Engineer at MSDGC

"That's very true. We have a lot of extreme weather events where people are getting backups, but not necessarily backups due to our sewer capacity, it's because we're getting so much rain that there's overland flooding, so to speak. They look to us to solve the problem, so people are aware that our rain events are only getting worse. So we have to find some sort of solution, other than our sewer system to deal with it" – Ian Laseke, Supervising Engineer at Metropolitan Sewer District of Cincinnati